VIBRATION AND ACOUSTIC TESTING FOR MARS MICROMISSION SPACECRAFT

Dennis L. Kern and Terry D. Scharton
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive, MS 157-410
Pasadena, CA 91109

ABSTRACT

Submitted for the Launch Vehicle Vibrations Conference, theme #8, oral session
First European Conference on Launcher Technology
Sponsored by Centre National d'Etudes Spatiales (CNES)
Toulouse, France
December 14-16, 1999

The objective of the Mars Micromission program being managed by the Jet Propulsion Laboratory (JPL) for NASA is to develop a common spacecraft that can carry telecommunications equipment and a variety of science payloads for exploration of Mars. The spacecraft will be capable of carrying robot landers and rovers, cameras, probes, balloons, gliders or aircraft, and telecommunications equipment to Mars at much lower cost than recent NASA Mars missions. The lightweight spacecraft (about 220 Kg mass) will be launched in a cooperative venture with CNES as a TWIN auxiliary payload on the Ariane 5 launch vehicle. Two or more Mars Micromission launches are planned for each Mars launch opportunity, which occur every 26 months. The Mars launch window for the first mission is November 1, 2002 through April 2003, which is planned to be a Mars airplane technology demonstration mission to coincide with the 100 year anniversary of the Kittyhawk flight. Several subsequent launches will create a telecommunications network orbiting Mars, which will provide for continuous communication with landers and rovers on the Martian surface. Dedicated science payload flights to Mars are slated to start in 2005.

This new cheaper and faster approach to Mars exploration calls for innovative approaches to the qualification of the Mars Micromission spacecraft for the Ariane 5 launch vibration and acoustic environments. JPL has in recent years implemented new approaches to spacecraft testing that may be effectively applied to the Mars Micromission. These include 1) force limited vibration testing, 2) combined loads, vibration and modal testing, and 3) direct acoustic testing. JPL has performed nearly 200 force limited vibration tests in the past 9 years; several of the tests were on spacecraft and large instruments, including the Cassini and Deep Space One spacecraft. Force limiting, which measures and limits the spacecraft base reaction force using triaxial force gages sandwiched between the spacecraft and the test fixture, alleviates the severe overtest at spacecraft resonances inherent in rigid fixture vibration tests. It has the distinct advantage over response limiting that the method is not dependent on the accuracy of a detailed dynamic model of the spacecraft. Combined loads, vibration, and modal testing were recently performed on the QuikSCAT spacecraft. The combined tests were performed in a single test setup per axis on a vibration shaker, reducing test time by a factor of two or three. Force gages were employed to measure the true c.g. acceleration of the spacecraft for structural loads verification using a sine burst test, to automatically notch random vibration test input accelerations at spacecraft resonances based on predetermined force limits, and to directly measure modal masses in a base drive modal test. In addition to these combined tests on the shaker, the QuikSCAT spacecraft was subjected to a direct field acoustic test by surrounding the spacecraft, still on the vibration shaker, with rock concert type acoustic speakers. Since the spacecraft contractor does not have a reverberant field acoustic test facility, performing a direct field acoustic test saved the program nearly two weeks schedule time that would have been required for packing / unpacking and shipping of the spacecraft.

This paper discusses the rationale behind and advantages of the above test approaches and provides examples of their actual implementation and comparisons to flight data. The applicability of the test approaches to Mars Micromission spacecraft qualification is discussed.

Author Information

	Dennis L. Kern	Terry D. Scharton
Phone:	(818) 354-3158	(818) 354-8368
Fax:	(818) 393-1156	(818) 393-1156
Email:	dennis.l.kern@jpl.nasa.gov	terry.d.scharton@jpl.nasa.gov